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VERSION WITH MARKINGS TO SHOW CHANGES MADE

Page 1, paragraphs [0000.2] through [0004]:

[0000.2] CROSS-REFERENCE TO RELATED APPLICATIONS

[0000.4] This application is a 35 USC 371 application of PCT/DE 00/01671 filed on May 24, 2000.

[0000.6] BACKGROUND OF THE INVENTION

[0001] [Prior Art] Field of the Invention

[0002] The invention relates to a piezoelectric actuator, for instance for actuating a mechanical component such as a valve or the like[, in accordance with the generic characteristics of the preamble to the main claim].

[0002.5] Description of the Prior Art

[0004] The aforementioned piezoelectric actuators are often used in the positioning of valves. Among other factors, it must be considered here that their stroke capacity for actuating a valve tappet, for instance, is relative slight for a comparatively great force. To increase the useful stroke, it is therefore [sometimes usual] known to provide a mechanical or hydraulic travel booster. Such mechanical or hydraulic travel boosting systems, however, entail greater effort and therefore greater expense as well.

Page 2, paragraph [0005]:

[0005] [Advantage of the Invention] SUMMARY OF THE INVENTION

Page 5, paragraph [0015] and [0016]:

[0015] These and other characteristics of preferred refinements of the invention will become apparent from [the claims and] the description and the drawings; the individual characteristics, each alone or a plurality of them in the form of subsidiary combinations, can be realized in the embodiment of the invention and in other fields and can represent both advantageous and intrinsically patentable embodiments for which patent protection is here claimed.

[0016] [Drawing] BRIEF DESCRIPTION OF THE DRAWINGS

Page 6, paragraph [0017]:

[0017] Exemplary embodiments of the piezoelectric actuator of the invention with a narrow design, for instance for positioning a valve, will be explained in conjunction with the [drawing. Shown are] drawings, in which:

Page 7, paragraph [0026] and [0027]:

[0026] [Description of the Exemplary Embodiments] DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0027] In Fig. 1, a piezoelectric actuator 1 is shown that has a piezoelectric element 2, which in a manner known per se is constructed of piezoelectric sheets of

a quartz material with a suitable crystalline structure, so that by utilizing the so-called piezoelectric effect upon application of an external electrical voltage to electrodes 3 and 4, a mechanical reaction of the piezoelectric actuator 1 is effected, in the form of a useful force [F_{useful}] F_u. The exemplary embodiment in Fig. 1 is not temperature-compensated and furnishes a compressive force [F_{useful}] F_u.

Page 8, paragraph [0030]:

[0030] A second exemplary embodiment of a piezoelectric actuator 20 is shown in Fig. 4; here, components functioning the same are identified by the same reference numerals as in Fig. 1. In the arrangement of Fig. 4, there is one piezoelectric element 21, and there are stabilizing elements 22 that are made from a ceramic material with approximately the same coefficient of temperature expansion as the piezoelectric element 21. The support plate 8 is prestressed here in the housing 10 via a spring 23; the prestressing force of the spring 23 must be substantially greater than that of the prestressing spring 6, so that the different temperature expansions between the housing 10 and the piezoelectric element 21 can be compensated for via the spring 23. However, it is also possible to omit the spring 23. Then the piezoelectric element 21 would be held together by the upper support plate 8, analogously to what Fig. 1 shows, and optionally also by a lower support plate. The upper support plate 8 would, as in Fig. 1, rest on a shoulder of the housing 10. The spring 23 prevents the stabilizing element 22 from being subject to tensile stress that can be caused by the prestressing of the piezoelectric element. This prestressing is accomplished with the aid of the spring 6.

Page 9, paragraph [0031]:

[0031] An actuation of the piezoelectric actuator 20, in this exemplary embodiment as well, leads to an axial expansion of the piezoelectric element 21 and thus to a compressive force [F_{useful}] $\underline{F_{u1}}$ counter to the prestressing of the prestressing spring 6. Since here as well the piezoelectric element 21 and the stabilizing elements 22 have essentially the same coefficients of temperature expansion, the temperature-caused expansions of the piezoelectric element 21 and of the stabilizing [element] elements 22, in the proposed mechanical mounting, cause the influences of the two elements 21 and 22 to be cancelled out in the effective direction. Thus the actuating element, connected to the spring plate 7 of the piezoelectric element 21, can remain in its position.

[0032] A third exemplary embodiment of a piezoelectric actuator 30 is shown in Fig. 5; once again, components that function the same are provided with the same reference numerals as in Fig. 1 or Fig. 4. In the arrangement of Fig. 5, in contrast to the disposition of Fig. 4, only [one] a piezoelectric element 31 [is provided] with longitudinally stacked piezoelectric layers is provided. An actuation of the piezoelectric actuator 30 in this exemplary embodiment leads to an axial shortening of the piezoelectric element 31 and thus to useful tensile force [F_{useful}] $\underline{F_u}$ that acts on the actuating element.

Page 10, paragraph [0034]:

[0034] From Fig. 8, a further exemplary embodiment of a piezoelectric actuator 40 can be seen; once again, the components functioning the same are

provided with the same reference numerals as in Fig. 1, Fig. 4 or Fig. 5. In the arrangement of Fig. 8, two piezoelectric elements 41 and 42 are disposed symmetrically to a tension rod 43, which represents the actuating element. The piezoelectric elements 41 and 42 and the tension rod 43 are disposed, surrounded by the intermediate layer 11, in the housing 10 of the piezoelectric actuator 40. The piezoelectric elements 41 and 42 here are furthermore held between a support plate 44, connected to the tension rod, and via the spring 23 on an upper fixation edge in the housing 10 and a lower fixation edge in the housing 10. This arrangement furnishes a tensile force as the force [F_{useful}] F_u and is not temperature-compensated.

Page 11, paragraph [0035]:

[0035] The foregoing relate to preferred exemplary embodiments of the invention, it being understood that other variants and embodiments thereof are possible within the spirit and scope of the invention, the latter being defined by the appended claims.

Page 16, abstract:

Abstract of the Disclosure

A piezoelectric actuator [is proposed,] in which at least on piezoelectric element [(2; 21; 31; 41, 42)] is present[,] for subjected an actuating element to a tensile force or compressive force. In addition, stabilizing elements [(9; 22)] are [provided, which] mounted parallel to the piezoelectric element [(2; 21; 31; 41, 42)] with a flexible intermediate layer [(11)] located between the elements. The piezoelectric element [(2; 21; 31; 41, 42)] and the stabilizing elements [(9; 22)] have a great length in the effective direction (Z axis) in proportion to their width transversely to the effective direction (X, Y direction).

[(Fig. 1)]